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Physical activity and sedentary behaviour of Canadian children aged 3 to 5

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Abstract

Background: For preschool children, physical activity is associated with improved measures of health, while sedentary behaviour is associated with less favourable health outcomes. This study updates estimates of physical activity and sedentary behaviour among children aged 3 to 5, based on combined data from two cycles of the Canadian Health Measures Survey (CHMS) in order to calculate adherence to Canadian physical activity and sedentary behaviour guidelines.

Data and methods: The data are from two independent samples that comprised the 2009-to-2011 (cycle 2) and 2012/2013 (cycle 3) CHMS. Accelerometry and a parent-administered questionnaire were used in both cycles on children aged 3 to 5. Accelerometer data, collected in 60-second epochs in cycle 2 and in 15-second epochs in cycle 3, were combined using an adjustment factor derived in an independent sample. Prevalence of adherence to the physical activity guidelines, according to the accelerometer data, was estimated based on a Betabinomial distribution. Adherence to the screen-time component of the sedentary behaviour guidelines was calculated using parent reports. Results are presented by personal and household-related covariates.

Results: An estimated 73% of 3- to 4-year-olds and 30% of 5-year-olds met their respective physical activity guidelines. Screen-time targets were met by 22% of 3- to 4-year-olds and 76% of 5-year-olds.

Interpretation: Because they rely on a larger sample size and stronger estimation methods, the findings of this study are more robust than previously published estimates. Results reveal room for improvement, particularly 5-year-olds' physical activity and 3- to 4-year-olds' screen time.

Key words: Betabinomial, pediatric, surveillance, screen time

For preschool children, physical activity is associated with improved measures of adiposity, motor skill development, psychosocial health and cardiometabolic health indicators,[1] while sedentary behaviour, notably screen time, is associated with increased adiposity and decreased psychosocial and cognitive development.[2] In 2012, this evidence was used to develop physical activity[3] and sedentary behaviour[4] guidelines for Canadian children aged 0 to 4.

During the 2009-to-2011 period, the Canadian Health Measures Survey (CHMS) employed accelerometers to obtain objective measures of physical activity among 3- to 5-year-olds. According to the accelerometer results, 84% of 3- to 4-year-olds met the guideline of at least 180 minutes of total physical activity on all valid days,[5] but based on parental reports, the percentage meeting the guideline of no more than 1 hour of daily screen time was 18%.[5] For 5-year-olds, the guideline of at least 60 minutes of daily moderate-to-vigorous physical activity (MVPA) was met by 14%, and 81% met the guideline of less than 2 hours of daily screen time.[5]

For a number of reasons, these findings require updating. The 2009-to-2011 accelerometer data were collected in 60-second epochs, but shorter epoch lengths are better able to capture the sporadic movement of young children.[6-8] In 2012/2013, the CHMS collected accelerometer data for children aged 3 to 5 in 15-second epochs with algorithms developed to adjust 60-second data to reflect 15-second epochs.[9] Therefore, it is now possible to combine data from the 2009-to-2011 and 2012/2013 CHMS for a more in-depth analysis of the physical activity and screen time of preschool children.

Another reason for updating the results relates to the methodology used to estimate the percentage of children meeting the physical activity guidelines. Previous estimates of the prevalence of adherence using a Bayesian approach assumed that a random day was active 50% of the time.[10,11] This assumption was not satisfactory for 3- to 5-year-olds, and a new approach was developed.[12]

The final reason for updating the physical activity results is the small sample size of individual CHMS cycles, which does not allow in-depth analyses. By combining cycles, associations between guideline adherence and variables such as body mass index (BMI),[13] household income,[14] household education,[15] presence of siblings,[16,17] and age of mother[18] can be investigated. Adherence to screen-time guidelines is assessed based on parent reports, and although no change in method occurred between cycles, the analysis benefits from a doubled sample size.

This study has three objectives. The first is to convert 60-second accelerometer epoch data into 15-second epochs. The second is to determine the prevalence of adherence to physical activity and sedentary behaviour guidelines among 3- to 5-year-olds. The third is to take advantage of the larger sample size to examine associations between personal and household characteristics and adherence to the guidelines.

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Methods

Data source

Data for this study were from cycles 2 (August 2009 through November 2011) and 3 (January 2012 to December 2013) of the CHMS, which were conducted at 34 sites across Canada. Each cycle collected data from respondents aged 3 to 79 living in private households. Residents of First Nations Reserves, institutions, some remote regions, or areas with low population density, and full-time members of the Canadian Forces were excluded. The sample represented more than 96% of the Canadian population.[19,20] Ethics approval was obtained from Health Canada's Research Ethics Board.[21] Detailed information about the content and sample design is available elsewhere.[19,20,22,23]

In addition to an in-person interview to obtain socio-demographic, health and lifestyle data, the CHMS involved a visit to a mobile examination centre (MEC) for direct physical measures.

The total population for the combined cycles was derived from the average population total for each collection period. Each cycle was adjusted based on the number of sites by cycle and region. The combined response rate for 3- to 5-year-olds—including the household questionnaire, MEC visit, and returning the accelerometer with at least three valid days of data—was 40.3%. In line with survey standards, non-response was modelled, and weights were adjusted to ensure that the sample remained representative.[19,20] Information about combining CHMS cycles is available elsewhere.[24]

A total of 865 participants aged 3 to 5 had valid accelerometer data and were included in this study.

Accelerometer data collection and reduction

Upon completion of the MEC visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for seven consecutive days. The Actical (dimensions: 2.8 x 2.7 x 1.0 centimetres; weight: 17 grams) measures and records time-stamped acceleration in all directions, providing an index of physical activity intensity. The Actical has been validated for measuring physical activity in preschool children.[25,26]

The accelerometers were initialized to collect data in 60-second epochs for cycle 2 and in 15-second epochs for cycle 3, starting at midnight following the MEC appointment. All data were blind to respondents while they wore the device. Respondents received a prepaid envelope in which to return the accelerometers to Statistics Canada, where the data were downloaded, and the devices were checked to determine if they still adhered to the manufacturer's calibration specifications.[27]

The digitized values collected by the accelerometers were summed according to the epoch length (60 or 15 seconds), resulting in a count per minute (cpm) or a count per 15 seconds (cp15s). A valid day was defined as five or more hours of wear time.[28] Wear time was determined by subtracting non-wear time from 24 hours. For cycle 2, non-wear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 2 minutes of counts between 0 and 100. For cycle 3, non-wear time was defined as at least 240 intervals of 15 seconds of zero counts, with allowance for 30 seconds of counts between 0 and 25.[10,28]

After invalid days were removed from the dataset, time spent at various activity intensities (sedentary, light, moderate-to-vigorous) was determined for valid days based on laboratory-derived cut-points corresponding to each intensity level. Total physical activity is the sum of light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA). The cut-points for MVPA were 1,150 cpm in cycle 2 and 288 cp15s in cycle 3.[25] To distinguish sedentary from LPA intensity, the cut-points were 100 cpm in cycle 2 and 25 cp15s in cycle 3.[29] For each respondent, time at each intensity level was summed for each day and averaged for valid days.

The Actical recorded seven days of data for cycle 2 respondents, but because of limited memory capacity when set at 15-second epochs, 5.6 days for cycle 3 respondents. To combine data from the two cycles, days 6 and 7 were dropped for cycle 2. Respondents with at least three valid days were retained for analysis.[30,31]

Data collected in different epochs yield different results.[32,33] Nonetheless, 15- and 60-second epoch data are highly correlated (R^2 ranging from 0.83 to 0.87). Correction factors (Table 1) were used to transform 60-second epoch data from cycle 2 into 15-second epoch data.[9] Wear time was obtained by summing sedentary, LPA and MVPA time. Steps per day were not combined due to the weak relationship (R^2 = 0.08) between data collected with different epoch lengths.[9]

Table 1
Regression equations for associations between 60- and 15-second epoch data for physical activity and sedentary time outcome variables

	Regression equation (x = 60-second epoch, y = 15-second epoch)	R^2
Moderate-to-vigorous physical activity (minutes per day)	y = 0.78x + 15.76	0.85
Light physical activity (minutes per day)	y = 0.72x + 6.67	0.85
Sedentary time (minutes per day)	y = 1.03x + 67.20	0.83
Total counts per day	y = 0.91x + 17,229	0.87

Source: Colley RC, Harvey A, Grattan KP, Adamo K. Impact of accelerometer epoch length on physical activity and sedentary behaviour. *Health Reports* 2014; 25(1): 3-9.

Meeting the guidelines

Different ages require different physical activity guidelines. The guidelines for 3- and 4-year-olds recommend at least 180 minutes a day of physical activity of any intensity,[3] and progression toward at least 60 minutes of energetic play by age 5. Progression toward energetic play was defined as accumulating at least 180 minutes of total physical activity a day, including increasing amounts of MVPA. The guidelines for 5-year-olds recommend at least 60 minutes of MVPA daily.[3,4]

As in American and Canadian studies of older children,[10,11] a Bayesian approach was employed to estimate the prevalence of adherence to the physical activity guidelines. Adherence follows a binomial distribution [Binomial(n,p)], where p is randomly distributed. A previous method assumed that p is distributed as a Uniform(0,1), with the average random day being active 50% of the time. However, in younger children, this assumption is not met—90% of random days of 3- to 4-year-olds are active. Assuming that p is distributed as a Beta(α, β) addresses this methodological constraint. The resulting conditional distribution for meeting the guidelines is a Betabinomial (n, α + active days, β + inactive days), where n = 7 is the number of days, and the parameters α and β are the parameters of the Beta distribution of the probability of a day being active and are estimated by maximum-likelihood. Information on the development of this method is available elsewhere.[12] For each combination of active and wear days, an individual probability was estimated. The preva-

Table 2
Sample characteristics, household population aged 3 to 4, Canada, excluding territories, 2009 to 2013 (combined)

	Total (n = 566)			Boys (n = 288)			Girls (n = 278)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	Estimate	from	to	Estimate	from	to	Estimate	from	to
Wear time (hours per day)	12.0	11.7	12.2	11.9	11.6	12.2	12.0	11.8	12.3
Sedentary time (minutes per day)	436	425	447	432	416	448	440	428	453
Light physical activity (minutes per day)	213	206	219	210	203	217	215	206	225
Moderate-to-vigorous physical activity (minutes per day)	69	66	72	71	68	74	66	62	70
Total physical activity (minutes per day)	283	274	291	282	274	291	283	271	295
Total counts per day (counts per day)	269,819	257,280	282,359	275,473	261,460	289,486	263,815	247,749	279,881
Average screen time (hours per day)	2.0	1.8	2.2	2.1	1.8	2.4	2.0	1.7	2.3
Height (cm)	102.9	101.9	104.3	103.8	102.5	105.7	102.0	100.3	104.3
Weight (kg)	17.3	16.9	17.9	17.9	17.3	18.6	16.8	16.1	17.8
Body mass index (kg/m²)	16.3	16.1	16.5	16.5	16.1	17.0	16.1	15.8	16.5
Household income (%)									
$0 to $39,999	20.8[t]	13.2	28.4	24.7[t]	15.0	34.5	16.6[t]	7.3	25.9
$40,000 to $79,999	29.3	22.9	35.7	28.0	19.6	36.4	30.7	23.2	38.1
$80,000 or more	49.9	39.5	60.4	47.3	34.8	59.7	52.8	40.4	65.1
Highest level of education in household (%)									
Secondary graduation or less	13.2	9.5	16.9	9.1[t]	5.5	12.8	17.5[t]	11.0	23.9
At least some postsecondary, less than bachelor's degree	38.3	30.5	46.2	41.5	31.8	51.2	35.0	25.2	44.7
Bachelor's degree	29.2	23.3	35.2	28.0	18.8	37.1	30.6	23.1	38.0
University degree or certificate above bachelor's degree	18.6[t]	11.7	25.6	20.3[t]	11.4	29.2	16.9[t]	9.5	24.4
Body mass index category (%)									
Healthy weight	66.2	60.5	71.9	63.3	57.0	69.6	69.2	59.5	78.9
At risk of overweight	25.4	19.8	31.1	26.8	19.4	34.1	24.0	16.3	31.8
Overweight or obese	7.7[t]	4.2	11.1	8.6[t]	4.5	12.7	F	...	...
Single-child household (%)									
Yes	18.7	13.5	23.9	20.0	13.4	26.6	17.4[t]	9.7	25.1
Mother's age at birth of child (%)									
Younger than 30	40.4	33.4	47.4	41.6	32.5	50.6	39.2	29.1	49.2
30 to 34	35.7	28.9	42.5	38.4	28.2	48.6	32.8	23.6	42.0
35 or older	23.9	18.6	29.1	20.0[t]	12.6	27.5	27.9[t]	16.6	39.2

... not applicable
[t] use with caution
F too unreliable to be published
Source: Canadian Health Measures Survey, combined 2009-to-2011 and 2012/2013.

lence of adherence is the weighted average of these individual probabilities.

The screen-time guideline for 3- to 4-year-olds is a maximum of 1 hour a day[4]; for 5-year-olds, the maximum is 2 hours.[35] As part of the CHMS household questionnaire, parents were asked about their child's screen time:

- On average, about how many hours a day does he/she watch TV or videos or play video games?
- On average, about how many hours a day does he/she spend on a computer (working, playing games, e-mailing, chatting, surfing the net, etc.)?

Response options in cycle 2 were: none, less than 1, 1 to 2, 3 to 4, 5 to 6, and 7 or more hours. Cycle 3 response options were: none, less than 1, 1 to less than 3, 3 to less than 5, 5 to less than 7, and 7 or more hours. Screen time was derived using the midpoints of these categories. Total screen time was obtained by summing the answers to the two questions.

Covariates

Height was measured to the nearest 0.1 cm using a ProScale M150 digital stadiometer (Accurate Technology Inc., Fletcher, USA), and weight, to the nearest 0.1 kg with a Mettler Toledo VLC with Panther Plus terminal scale (Mettler Toledo Canada, Mississauga, Canada).

Body mass index (BMI) was derived as weight in kilograms divided by height in metres squared. Based on BMI and age- and sex-specific cut-offs specified by the World Health Organization,[36] 3- and 4-year-olds were classified as thin, normal weight, at risk of overweight, overweight, or obese. For 5-year-olds, the categories were thin, normal weight, overweight or obese.[37] Owing to small sample sizes, results for thinness are not presented, and overweight and obesity were combined.

Table 3
Sample characteristics, household population aged 5, Canada, excluding territories, 2009 to 2013 (combined)

	Total (n = 299)			Boys (n = 143)			Girls (n = 156)		
		95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	**Estimate**	**from**	**to**	**Estimate**	**from**	**to**	**Estimate**	**from**	**to**
Wear time (hours per day)	12.4	12.1	12.7	12.6	12.2	13.0	12.2	11.8	12.5
Sedentary time (minutes per day)	458	444	472	463	447	478	453	434	472
Light physical activity (minutes per day)	211	202	219	213	202	223	208	196	221
Moderate-to-vigorous physical activity (minutes per day)	75	70	80	81	77	85	68[†]	62	74
Total physical activity (minutes per day)	287	276	298	295	282	308	278	261	294
Total counts per day (counts per day)	292,597	275,272	309,922	313,668	296,800	330,536	269,777[†]	246,713	292,842
Average screen time (hours per day)	2.2	1.8	2.6	2.1	1.7	2.6	2.3	1.6	3.1
Height (cm)	113.0	111.6	114.8	112.8	110.7	115.6	113.3	111.7	115.4
Weight (kg)	21.0	20.0	22.2	21.2	20.1	22.8	20.6	19.5	22.1
Body mass index (kg/m²)	16.3	15.9	16.9	16.6	16.1	17.3	15.9	15.4	16.7
Household income (%)									
$0 to $39,999	19.2[E]	12.0	26.5	23.8[E]	13.5	34.0	F	...	...
$40,000 to $79,999	32.7[E]	21.1	44.3	32.4[E]	19.4	45.4	33.0[E]	16.0	50.1
$80,000 or more	48.0	38.9	57.2	43.8	32.5	55.1	52.6	41.8	63.4
Highest level of education in household (%)									
Secondary graduation or less	10.8[E]	5.6	16.0	14.9[E]	7.3	22.5	F	...	...
At least some postsecondary, less than bachelor's degree	40.8	30.6	50.9	31.6[E]	19.3	43.9	50.7	36.2	65.2
Bachelor's degree	29.2	20.6	37.8	31.2[E]	16.8	45.6	27.0	20.5	33.6
University degree or certificate above bachelor's degree	17.7[E]	8.7	26.8	22.0[E]	11.2	32.7	F	...	...
Body mass index category (%)									
Healthy weight	68.7	58.9	78.5	67.4	54.4	80.4	70.1	59.4	80.8
Overweight or obese	31.3	21.5	41.1	32.6[E]	19.6	45.6	29.9[E]	19.2	40.6
Single-child household (%)									
Yes	18.4[E]	10.8	26.1	12.9[E]	5.6	20.2	24.4[E]	11.2	37.6
Mother's age at birth of child (%)									
Younger than 30	38.1	26.7	49.4	45.7	34.5	56.8	29.8[E]	15.0	44.6
30 to 34	29.2	22.0	36.5	25.4	16.9	33.9	33.4[E]	20.1	46.7
35 or older	30.4	19.7	41.1	24.5[E]	11.8	37.2	36.8[E]	22.0	51.5

... not applicable
[E] use with caution
F too unreliable to be published
[†] significantly different from boys ($p < 0.05$)
Source: Canadian Health Measures Survey, combined 2009-to-2011 and 2012/2013.

Highest level of education in the household was defined in four categories: secondary graduation or less (no postsecondary); at least some postsecondary, but less than a bachelor's degree (including some postsecondary, trade school, college or CEGEP diploma or certificate, and less than bachelor's level university certificate); bachelor's degree; and university degree above the bachelor's level.

Three household income groups were defined: less than $40,000, $40,000 to $79,999, and $80,000 or more. The household was defined as a single-child household if no other children younger than 18 lived in the dwelling. Mother's age at the birth of the child was classified as younger than 30, 30 to 34, and 35 or older.

Statistical analysis

Descriptive statistics were used to report average time at different physical activity intensities and the percentage of the population meeting the guidelines.

Because of the non-linear nature of individual prevalence of adherence to the physical activity guidelines, a ln(y/1-y) transformation was applied to this variable before it was used in the multiple linear regression analyses. Meeting the screen-time guidelines was modelled using a multiple logistic regression. Because of different guidelines and differences in BMI categories, separate models were completed for 3- to 4-year-olds and for 5-year-olds. Models were adjusted for sex, BMI category, household income, highest level of education in the household, presence of other children in the household, and mother's age at the birth of the child.

All analyses were performed using SAS v9.3 (SAS Institute, Cary, NC) and

Table 4
Adherence to physical activity and screen-time guidelines, by age group and selected characteristics, household population aged 3 to 5, Canada, 2009 to 2013 (combined)

	Ages 3 to 4						Age 5					
	At least 180 minutes of physical activity every day			One hour or less of parent-reported daily screen time			At least 60 minutes of moderate-to-vigorous physical activity every day			Two hours or less of parent-reported daily screen time		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Characteristic	Estimate (%)	from	to	Estimate (%)	from	to	Estimate (%)	from	to	Estimate (%)	from	to
Total	73.3	69.6	77.0	21.6	16.0	27.2	29.7	22.8	36.5	76.3	67.9	84.8
Boys	71.7	66.7	76.7	18.8	12.6	25.0	33.9	27.0	40.8	76.7	67.3	86.0
Girls†	75.0	70.1	80.0	24.6	16.2	33.0	25.1E	15.6	34.6	76.0	60.7	91.3
Body mass index category												
Healthy weight†	74.6	70.3	78.8	24.0	17.4	30.6	32.4	25.1	39.7	72.3	59.9	84.8
At risk of overweight	71.0	61.0	80.9	17.4E	8.8	26.0	...	...	...	...	...	...
Overweight or obese	71.5	54.5	88.6	F	...	...	23.7E	14.1	33.4	85.1	72.9	97.4
Household income												
$0 to $39,999	64.4*	57.1	71.7	F	...	...	22.1E	13.2	31.0	74.6	55.1	94.2
$40,000 to $79,999	72.8	64.7	80.8	26.6E	17.2	36.1	33.2	25.3	41.2	81.5	71.9	91.1
$80,000 or more†	77.3	74.0	80.7	22.1	13.8	30.4	30.3	20.9	39.7	73.5	59.7	87.3
Highest level of education in household												
Secondary graduation or less	75.2	64.5	85.8	F	...	...	33.3E	17.0	49.7	78.3	63.3	93.3
At least some postsecondary, less than bachelor's degree	73.3	66.2	80.4	13.5*E	7.8	19.2	29.6E	20.5	38.8	74.4	58.3	90.4
Bachelor's degree	72.2	66.0	78.4	25.3	16.6	34.0	30.9	15.7	46.1	85.5	74.9	96.0
University degree or certificate above bachelor's degree†	73.3	64.5	82.2	34.7	22.8	46.5	26.8E	14.9	38.7	67.4	42.3	92.5
Single-child household												
Yes	70.6	61.4	79.8	17.2E	7.3	27.1	20.7E	8.4	33.0	52.4*E	26.9	78.0
No†	73.9	69.2	78.7	22.6	16.1	29.2	31.7	25.0	38.4	81.7	75.6	87.9
Mother's age at birth of child												
Younger than 30†	73.2	68.2	78.2	22.1	13.2	30.9	37.6	28.0	47.3	80.5	69.7	91.3
30 to 34	69.9	63.7	76.2	24.7	16.3	33.1	28.3E	16.1	40.5	79.7	66.9	92.5
35 or older	78.6	72.7	84.4	16.1	5.2	27.0	22.8*E	12.9	32.6	70.3	49.8	90.7

... not applicable
E use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)
† reference category
Source: Canadian Health Measures Survey, combined 2009-to-2011 and 2012/2013.

were based on weighted data for the combined CHMS cycles 2 and 3 accelerometer data. To account for survey design effects, standard errors, coefficients of variation such as 95% confidence intervals, and t-tests were estimated with the bootstrap techniques using 24 degrees of freedom. Statistical significance was set at 0.05.

Results

Physical activity

Three- to 4-year-olds wore the accelerometer an average of 12 hours on valid days (Table 2); 90% wore it for at least 10 hours a day (data not shown). On average, they accumulated 283 minutes (4 hours, 43 minutes) of physical activity a day, 69 minutes of of which were MVPA.

Five-year-olds wore the accelerometer an average of 12 hours and 24 minutes on valid days (Table 3); 97% wore it for at least 10 hours a day (data not shown). They accumulated an average of 75 minutes of daily MVPA—boys accumulated significantly more than girls (81 versus 68 minutes).

An estimated 73% of 3- to 4-year-olds met the guideline of 180 minutes of any physical activity (LPA or MVPA) on 7 out of 7 days (Table 4). No significant difference was observed between boys and girls. Among 5-year-olds, the recommendation of at least 60 minutes of MVPA on 7 out of 7 days was met by 30%.

For 3- to 4-year-olds, the guidelines recommend progression toward 60 minutes of energetic play, or MVPA, on a daily basis by age 5. Figure 1 shows progression toward this target. The percentage of 3- to 4-year-olds accumulating at least 180 minutes of physical activity, including at least 20 minutes of MVPA, was 73%. For 60 minutes of MVPA, the estimate was 24%.

When the other covariates were taken into account, 3- to 4-year-olds in the lowest income households were significantly less likely than those in the highest income households to meet the physical activity guidelines (Table 5). At age 5, boys were significantly more likely than girls to meet the guidelines.

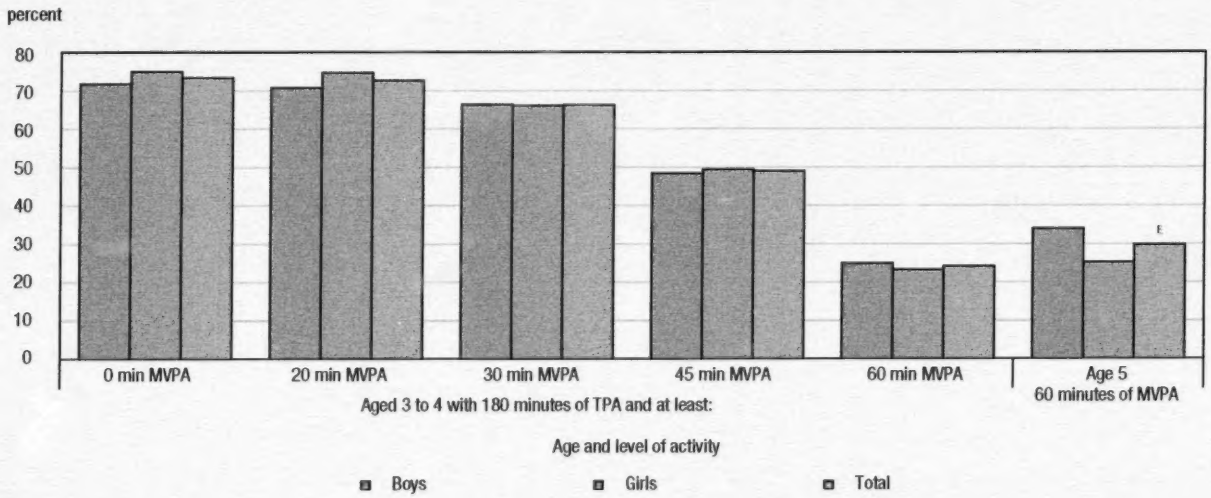
Sedentary behaviour

On average, 3- to 4-year-olds were sedentary 436 minutes a day (7 hours and 16 minutes), which was equivalent to 60.7% of their wear time (Table 2). For 5-year-olds, the figures were 458 minutes (7 hours and 38 minutes) and 61.5%, respectively (Table 3). Parent-reported screen time averaged 2 hours a day for the younger age group, and 2.2 hours a day for 5-year-olds.

Screen-time guidelines differ for 3- to 4-year-olds and for 5-year-olds: no more than 1 hour a day and no more than 2 hours a day, respectively. Parents reported 1 hour or less of screen time for 22% of 3- to 4-year-olds (Table 4), and 2 hours or less for 76% of 5-year-olds.

Based on the adjusted model, 3- to 4-year-olds in households with a lower level of education were significantly less likely than those in households with the highest level of education to meet the screen-time guidelines (Table 5). Five-year-olds in households with no other children were significantly less likely to meet the screen-time guidelines than were those in households with other children. In both age groups, children

Figure 1
Prevalence of adherence to different levels of activity, by sex and age group, household population aged 3 to 5, Canada excluding territories, 2009 to 2013 (combined)



E use with caution
Notes: TPA: Total physical activity. MVPA: Moderate-to-vigorous physical activity.
Source: Canadian Health Measures Survey, combined 2009-to-2011 and 2012/2013.

who met the physical activity guidelines were no more or less likely to meet the screen-time guidelines than were those who were less active (data not shown).

Discussion

This study updates physical activity and screen-time data for 3- to 5-year-olds in Canada. The combination of multiple cycles of data and the application of new, more robust methods contributes to an understanding of the current state of physical activity and sedentary behaviour among preschoolers.

Compared with 5-year-olds, children aged 3 to 4 were more likely to meet the physical activity guidelines and less likely to meet the screen-time guidelines. However, the guidelines for 3- to 4-year-olds recommend a larger volume of less intense activities and half the screen time recommended for 5-year-olds. The physical activity guidelines for 3- to 4-year-olds also recommend progression toward the 5-year-olds' guideline of 60 minutes of MVPA daily. On this criterion, results for 3- to 4-year-olds and 5-year-olds were more comparable.

Previous estimates of the percentage of children meeting the screen-time guidelines based on cycle 2 data are not statistically different from the results based on combined cycle 2 and 3 data. In the latter case, the same parent-reported questions and estimation method were used, but the sample was doubled.

Methodological issues are involved in comparisons of cycle 2 and combined cycle 2 and 3 estimates of the percentage of children meeting the physical activity guidelines. Based only on cycle 2 accelerometer data collected in 60-second epochs,[5] 84% of 3- to 4-year-olds and

Table 5
Adjusted odds ratios relating prevalence of adherence to physical activity and screen-time guidelines to selected characteristics, by age group, household population aged 3 to 5, Canada excluding territories, 2009 to 2013 (combined)

	Ages 3 to 4						Age 5					
	At least 180 minutes of physical activity every day			One hour or less of parent-reported daily screen time			At least 60 minutes of moderate-to-vigorous physical activity every day			Two hours or less of parent-reported daily screen time		
	Adjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
Characteristic		from	to		from	to		from	to		from	to
Sex												
Boys	0.94	0.66	1.34	0.69	0.39	1.24	2.35*	1.04	5.51	0.82	0.29	2.30
Girls†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Body mass index category												
Healthy weight†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
At risk of overweight	0.89	0.52	1.56	0.73	0.37	1.41	...	...	...	...	...	...
Overweight or obese	0.89	0.35	2.32	0.66	0.00	490.45	0.49	0.20	1.30	3.10	0.49	19.76
Household income												
$0 to $39,999	0.43*	0.28	0.67	0.71	0.23	2.22	0.53	0.19	1.53	1.21	0.28	5.27
$40,000 to $79,999	0.71	0.43	1.19	1.40	0.62	3.13	0.72	0.25	2.17	1.85	0.49	7.02
$80,000 or more†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Highest level of education in household												
Secondary graduation or less	1.92	0.86	4.44	0.42	0.12	1.42	0.90	0.13	6.84	1.76	0.22	14.36
At least some postsecondary, less than bachelor's degree	1.26	0.64	2.59	0.28*	0.13	0.60	0.85	0.28	2.75	1.42	0.21	9.55
Bachelor's degree	1.02	0.50	2.15	0.62	0.33	1.15	1.19	0.37	4.08	2.48	0.58	10.59
University degree or certificate above bachelor's degree†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Single-child household												
Yes	0.85	0.44	1.68	0.78	0.33	1.87	0.57	0.16	2.25	0.24*	0.08	0.68
No†	1.00			1.00			1.00	...	...	1.00	...	...
Mother's age at birth of child												
Younger than 30†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
30 to 34	0.90	0.57	1.45	1.03	0.47	2.24	0.31	0.10	1.03	1.30	0.34	4.94
35 or older	1.33	0.85	2.10	0.53	0.16	1.68	0.37	0.14	1.03	0.87	0.30	2.52

... not applicable
* significantly different from reference category ($p < 0.05$)
† reference category
Source: Canadian Health Measures Survey, combined 2009-to-2011 and 2012/2013.

14% of 5-year-olds were active on all valid days. Had the Betabinomial approach been used, the respective estimates would be 86% and 18%[12]; further adjustment for 15-second epochs would yield estimates of 75% and 26%, respectively.[12] Thus, the results are not statistically different. The advantages of the updated estimates are that they rely on more robust estimation methods and use data collected in an epoch length more appropriate for this age group.

Most studies of children aged 2 to 6 find that boys are more active and less sedentary than girls.[14,16,17,38] In this analysis, only among 5-year-olds were boys more likely than girls to meet the physical activity guidelines. No differences in total physical activity emerged between 3- to 4-year-old boys and girls, although boys accumulated 5 more minutes of MVPA. This tendency was more pronounced among 5-year-olds (13 minutes' difference) and led to a significant difference in the percentages of boys and girls meeting the guidelines in the adjusted model.

The presence of other children in the household may stimulate children to be more active.[16] Having siblings has been associated with physical activity and sedentary behaviour among 2-year-olds,[16] but not among older preschoolers.[17] In this analysis, having siblings was associated only with 5-year-olds' meeting the screen-time guidelines.

Similar to the present findings, other studies have shown lower household education to be associated with more screen time for 3-year-olds[15] and for 3- to 6-year-olds.[14]

Limitations

A number of limitations should be considered in evaluating these results.

Combining cycles meant removing days 6 and 7 from cycle 2 accelerometer data. However, time spent at different activity intensities did not differ between the day-6/day-7 averages and the day-1-through-5 averages (data not shown).

Accelerometers cannot accurately measure some activities (for example, load-bearing, cycling),[39] a limitation that could result in underestimation.

Time spent at various intensities depends on the thresholds that are used.[40] Small adjustments (for example, using a threshold of 50 cpl5s instead of 25 cpl5s to identify sedentary time) could potentially result in large differences.

Screen time was parent-reported; recall errors, social desirability and not being with the child throughout the day (day care, for example) may influence parents' answers. In addition, not all types of screen devices are listed (for example, smartphones, tablets).

Combining cycles doubled the sample size and allowed examination of associations with personal and household variables. Even so, few associations proved to be significant, suggesting that other factors might be more pertinent. A number of potential correlates could not be considered, either because they were not included in both CHMS cycles (such as time spent outside, child care attendance), or were absent from the survey (for instance, physical activity preference, intention, barriers to physical activity, program or facility access).[16,17,38,41]

Inconsistencies in preschool physical activity measurement due to the use of different accelerometer devices with various epoch lengths, data cleaning protocols, and activity intensity thresholds preclude comparisons with other studies.[40]

Conclusion

Because they rely on age-appropriate collection and estimation methods and a larger sample size, prevalence estimates of adherence to physical activity and screen-time guidelines in this study are more robust than previously published estimates. This allows more precision and creates the potential for more detailed correlate associations. The results of the analysis indicate room for improvement, particularly in 5-year-olds' physical activity and in 3- to 4-year-olds' screen time.

What is already known on this subject?

- Physical activity and sedentary behaviour guidelines for Canadian preschoolers were developed in 2011 and 2012.
- Previous estimates of the prevalence of adherence to the physical activity guidelines among 3- to 5-year-olds relied on accelerometer data collected in 60-second epochs and a relatively small sample size, and did not use a probabilistic approach.

What does this study add?

- In 2012/2013, accelerometer data were collected in 15-second epochs.
- Earlier 60-second epoch data were converted and combined with these 15-second data, thereby doubling the sample size.
- A more robust method relying on a Betabinomial distribution was used to estimate prevalence of adherence to the physical activity guidelines.
- An estimated 73% of 3- to 4-year-olds and 30% of 5-year-olds met their respective physical activity recommendations.

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